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NEW COMMERCIAL PROCESS FOR REMOVING CARBONPROCESS FROM UTILITY FLY ASH

Casimir J. Koshinski, P.E.
cas@pmet-inc.com
Phone: (724) 843-5000
Fax: (724) 843-5353
Pittsburgh Mineral & Environmental Technology, Inc. (PMET)
700 Fifth Avenue
New Brighton, PA 15066

and

Albin Friedrich
afriedrich@hmps.hosokawa.com
Phone: (908) 273-6360
Fax: (908) 273-7432
Hosokawa Micron Powder Systems (HMPS)
10 Chatham Road
Summit, NJ 07901

This presentation summarizes an innovative process for removing unburned carbon from utility fly ash that is being commercialized by Pittsburgh Mineral & Environmental Technology (PMET) and Hosokawa Micron Powder Systems (HMPS). This process, which utilizes commercially available equipment manufactured by Hosokawa

- reduces the carbon content in product ash to target levels regardless of the amount and characteristics of the carbon contained in the feed ash,
- improves pozzolanic properties by reducing the average particle size of the low-carbon ash product, thereby decreasing the water required in the concrete mix and increasing the strength of the resulting concrete product,
- can be easily adjusted and customized to maximize recovery from a wide variety of ashes, and
- provides the capability of simultaneously desorbing ammonia from ash resulting from systems designed to inject ammonia into the flue gas to reduce NOx emission and / or improve precipitator efficiency.

This proprietary process is low-maintenance, requires little operator attention, has projected operating efficiency of 95% based upon 24-hour per day, 365-days per year operation, and has projected capital, operating, and maintenance costs that are competitive with those of currently used processing strategies.

Process Description

The general principles of the fluidized jet mill and classification processes incorporated within the AFG equipment are as

follows:

- raw material, in this case fly ash from coal fired power stations, is loaded into the “grind chamber”,
- pressurized air, entering from a series of nozzles located around the perimeter of the chamber, fluidizes and accelerates the fly ash particles from the outer areas of the chamber to a centralized core where the high velocity particles impact each other,
- the energy of the particle-to-particle impacts instills a grinding action within the central core area. Use of lowest necessary air pressure ensures that the grinding action results in the reduction of only the most friable particles (carbon) within the chamber,
- after convergence, the air stream, with fluidized ash, is directed upwards to a dynamic classifier wheel for separation by air classification. Downstream of the classifier wheel is a blower unit (suction) and a baghouse. The blower unit serves to maintain ambient or slightly negative pressure in the mill, as well as to convey the fine, light carbon byproduct to the baghouse, and
- upon adequate reduction of carbon content, low LOI product ash is discharged through the bottom of the mill, after which the cycle repeats itself.

Process Results

Results obtained through demonstration tests performed at HMPS Technical Center in Summit, NJ using a Model 400 AFG are presented in tables below.

Table 1
Demonstration of LOI Reduction

Ash	Raw Ash LOI (wt%)	Product LOI (wt%)
1	5.7	2.7
2	7.7	2.6
3	6.3	3.5
4	12.3	3.6
5	7.4	3.3
6	8.8	2.8
7	16.5	4.1
8	8.2	2.5
For Ashes Below, Specification for Product = 6.5% LOI		
9	11.3	3.9
10	7.6	4.3
11	8.2	4.3

Table 2
Product Ash Pozzolanic Properties

Test	ASTM C618 Class F Ash Requirements	Typical Product Ash	Compared to Feed Ash Characteristics
Fineness (+325 Mesh)	34% Max	10% - 15%	Lower
Loss-on-Ignition	6% Max	2% - 4%	Lower
Soundness	0.8% Max	0.00%	Same
S.A.I. (7 days)	75.0% Min	76% - 80%	Same - Higher
S.A.I. (28 days)	75.0% Min	90% - 95%	Same - Higher
Water req, % Control	105% Max	97% - 99%	Lower

Ammonia Removal

PMET and HMPS have also tested several ammoniated ash materials generated by plants injecting ammonia/urea as part of selective catalytic reduction (SCR) technology as well as in ash conditioning to improve precipitator collection efficiency. In these tests, ammonia content of the product ash was significantly reduced to levels that are considered to be saleable[1]. Analysis of dust collector products indicate that desorbed ammonia is collected along with the carbon rich byproduct as the air cools. Specific results are presented in Table 3.

Desorption of ammonia requires no additional process cost since the increase in air temperature provided by the compressor has been demonstrated to be sufficient in achieving these levels.

Table 3
Demonstration of Ammonia Removal Capability

Feed Ash Ammonia-Nitrogen (mg/kg)	Product Ash Ammonia-Nitrogen (mg/kg
168	62
554	110
259	99

1 Larrimore, L., Dodgen, D., and Monroe, L., "Characterization of Ammonia Effects on Ash and Evaluation of Removal Methods", 13th International Symposium on Use and Management of Coal Combustion Products (CCPs)", Orlando, FL. Vol. 1 pp. 16-1 thru 16-15. 1999

Equipment Description

The AFG jet milling system (and selective jet milling system) was developed for use with abrasive products requiring fine grinding and minimal maintenance. In the AFG, a fluid media, in this case compressed air, is used instead of mechanical means to supply the energy required to grind the material. The AFG mill can be viewed as a mill broken into two major components:

- the grinding chamber, and
- the dynamic classifier head.

The components and dynamics of these sections are described below.

The grind chamber is a cylindrical type chamber with a conical bottom section sealed by a valve for discharging the low LOI ash product. Multiple nozzles are located in the bottom section of the grind chamber, mounted in opposing directions. When filling the grind chamber approximately 20% of the bed depth is above the location of these nozzles. During processing, air enters through these nozzles and causes the entire bed of material to become fluidized. The escape velocity from these converging / diverging nozzles can approach speeds of 300 to 400 meters/sec. As fluidized material comes in contact with these airstreams, the material is accelerated towards a focal point in the center of the mill. At this point, material from opposing airstreams will collide and interparticulate collisions cause the material to grind itself apart. Depending on the air pressure, air temperature, nozzle diameter, nozzle position and amount of nozzles, this "grinding zone" can be adjusted to characteristics of the material and the desired end-product. In the case of fly ash beneficiation, the pressures and velocities are kept relatively low to permit grinding of the more friable carbon instead of the desirable minerals in the ash.

Air can only exit the mill by passing through the dynamic classifier wheel(s) located at the top of the mill. The fast moving airstream carries with it almost all particles from the "grinding zone". As this airstream escapes through the classifier wheel to the baghouse, there are two main forces acting on the particles in the area of this wheel.

- A drag force caused by the airstream pulling the particle along, and
- A centrifugal force trying to throw the particles out of the wheel back into the mill.

Large and/or dense particles (i.e., unground carbon and / or minerals) get rejected from the classifier wheel and thrown back into the grind chamber for further processing. Small and / or light particles are more subject to the drag force caused by the airflow and pass through the wheel and into the baghouse. Since the speed of this classifier wheel is adjustable, different cut points of the fine material are attainable. Typically, for larger systems, multiple classifier wheels are installed which offers more precise control. Classifier wheels can be constructed from wear resistant materials to extend service intervals.

Control of the carbon removal can be either a function of processing time per ton of material or based on a weight loss of the product in the grind chamber.

Summary

In summary, work performed by PMET and HMPS in the area of ash beneficiation has conclusively demonstrated that

- the process to selectively grind and classify unburned carbon contained in fly ash is effective in reducing the product LOI to targeted levels,
- the pozzolanic properties of product ash are much improved versus those of the parent ash,
- ammonia can be simultaneously desorbed from the ash product with no additional processing cost, and
- the equipment has extensive operating experience in alternative industries and is well suited for the rigorous conditions associated with processing ash.